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UNHOLTZ-DICKIE CORPORATION

vibration generation systems and measurement instruments

Model 610 RMG-3

MP MASTER
MA34558

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UNHOLTZ-DICKIE CORPORATION
Hamden, Connecticut

Operating Instructions

for

Model 61ORMG3

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OPERATING INSTRUCTIONS

MODEL 610RMG3

GENERAL

The Model 610RMG3 is a triple channel instrument. Each channel includes a high impedance input cathode follower, a driven shield triaxial input cable, a variable gain amplifier, two successive stages of integration, a meter amplifier and a transistorized current amplifier. The inter-connection between these elements can best be understood by referring to the block diagram and the individual instrument schematic. The variable gain amplifier has a maximum gain of 1000 when the sensitivity dial is set at 1. The gain is adjustable between 1000 and 100 by the sensitivity dial. It can be further attenuated by the sensitivity range switch. Thus the instrument can be used as an X10, X100, X1000 amplifier. These gain figures refer to the output of the amplifier which is connected to the meter range switch. These instruments have been modified to provide an attenuated output from the variable gain amplifier which is proportional to acceleration. This output has been normalized at a sensitivity of 10 millivolts rms/g peak. Other values can be provided. It is the acceleration signal available at the rear of chassis jack. The unattenuated output is normalized at 1 v/g and is brought to the front panel jacks. It drives the integrator section and also the meter range switch when the meter function switch is in the acceleration position.

The first integrator section provides an output proportional to velocity. This output is normalized at a sensitivity of 96.4 mv(rms)/in/sec.(rms). The velocity output is available at the front panel jack marked AVD when the AVD switch is in the V position. The velocity sensitivity is at the proper level for direct connection to any Bruel and Kjaer shaker servo control. Note that the acceleration output sensitivity of 10 millivolts rms/g peak is 40% higher than that required by the standard B-K servo control. The B-K is normally adjusted for a sensitivity of 10 mv peak/g peak.

The velocity output also drives the displacement integrator. The displacement output is normalized at a sensitivity of 1 v(rms)/in. double amplitude. The displacement output is available at the front panel jack and is also connected to the meter range switch when the meter function switch is in the "Disp." position.

Both the meter amplifier and the galvanometer amplifier are connected to the meter range switch. This results in the galvanometer amplifier output being directly related to the meter reading. Thus, when the meter range switch is rotated to change meter scales, the galvanometer amplifier output is changed by the same scale factor. When the meter reading goes off scale, it is usually desirable to adjust both the meter range and the galvanometer range. However, there are cases where it may not be desirable to alter the drive to the galvanometer. In these cases, the meter may be left on one range even when the meter is pegging. The meter circuit is designed such that it may be overdriven indefinitely without damage to the meter or

associated circuitry. Also, note that the galvanometer amplifier is connected to the same function as the meter is monitoring. Thus, if the meter is monitoring acceleration, the galvanometer amplifier is connected to the acceleration signal, and if the meter is monitoring displacement, the galvanometer amplifier is connected to the displacement signal. If it is considered undesirable to have the galvanometer amplifiers interlocked with the indicating meters, it is possible to modify the instrument so as to separate these two functions.

GALVANOMETER CURRENT AMPLIFIER

Oscillographs which will record AC signals up to 5 KC are available from such manufacturers as CEC, Minneapolis-Honeywell, Sanborn etc. These recorders utilize a galvanometer to deflect a light beam. To achieve the high frequency response the galvanometers are very small and the coils have relatively few turns. Thus, considerable current (up to 100 ma) is required to obtain full deflection. Typical voltage amplifiers will not deliver this much current. The 610RMG3 includes a transistor current amplifier for this purpose.

In order to obtain a flat frequency response, most galvanometers require external electrical damping. This is obtained by inserting the proper resistance in series, or series parallel with the galvanometer. The 610RMG3 includes enough voltage swing to drive the galvanometers and series damping resistors. In most cases the damping resistors also serve to limit the amplifier output to 100 ma, the safe limit for most galvanometers. If necessary, an additional series resistor and parallel Zener diode may be added, to clip at the appropriate level for the galvanometer chosen. Since the damping resistor required depends on the galvanometer used, there are no resistors inserted unless a specific galvanometer has been specified. However, a terminal strip is provided to insert the required resistors. Alternately, the resistors may be located in the cable to the galvanometer.

OPTIONAL TAPE OUTPUT

In some cases it is desirable to drive both oscillograph and tape recorders simultaneously. In this case, the 1 K load resistor on the galvanometer amplifier may be replaced by a potentiometer, and the wiper brought to a tape output jack. Thus, two outputs with separate gain controls can be provided.

DIAL-A-GAIN FEATURE

The Dial-A-Gain has a cathode follower input and output, and is a continuously variable gain amplifier with a minimum gain of 10 and a maximum gain of 1000, thereby allowing its use with accelerometer sensitivities of 1 mv to 100 mv/g. The overall gain is adjusted by a ten turn precision pot and a two range decade switch. However, unlike other amplifiers, the gain control dial is not calibrated in terms of gain, but rather in terms of the reciprocal of gain. Thus, doubling the gain control dial setting halves the gain, tripling it reduces the gain to one-third etc. With such a scale arrangement, the amplifier output will be constant if the input signal corresponds to the scale setting. The overall gain is set so that the gain control dial reads directly in terms of the voltage input necessary to produce 1 g at the meter. This dial is called the "Sensitivity Dial".

To calibrate the meter for use with a specific accelerometer, set the dial to the accelerometer plus cable sensitivity in mv(rms)/g peak and set the range switch to obtain the proper decimal point.

OPERATING HINTS

1. Many old style accelerometers are sensitive to air currents, generating low frequency signals as a result of the air currents flowing past the accelerometer case. These low frequency transients make displacement measurements difficult. To avoid this problem, the accelerometer should be covered, or may be shielded by wrapping with several turns of soft rubber (not plastic) tape.

2. To avoid ground loop problems it is usually advisable to electrically isolate the accelerometer from the test specimen. This can be accomplished with isolating studs available from the accelerometer manufacturers, or by attaching the accelerometers to phenolic blocks which are, in turn, cemented to the specimen.

STANDARDIZATION PROCEDURES

General:

Standardization of each readout channel is the process of adjusting the channel gain such that when used with a specific accelerometer and cable the meters will indicate 1 g when the accelerometer is subjected to 1 g vibration. In addition, the desired galvanometer deflection should be selected. There are several approaches to this problem as outlined below:

1) Standardizing with the Dial-A-Gain feature.

If the combined sensitivity of the accelerometer and its cable (usually 3 feet or 10 feet coax) is know, together with the cable capacitance and accelerometer capacitance, then the proper sensitivity dial setting can be calculated as follows:

$$S = S_{a+c} \left(\frac{C_a + C_c}{C_a + C_c + C_i} \right)$$

where S_{a+c} = sensitivity of accelerometer with its cable or a specified external capacitance

C_a = capacitance of the accelerometer

C_c = capacitance of the accelerometer cable or the specified external capacitance used when calibrating.

C_i = input capacitance of the Dial-A-Gain including effective capacitance of the Triax cable.

C_i = 40 ppf for 25 foot cables

C_i = for 50 foot cables

To standardize each meter readout simply set the sensitivity dial and range switch to the value of S calculated above.

2) Standardizing against a reference accelerometer and Dial-A-Gain.

With this approach the accelerometers are all mounted on the specimen and cables connected to the readout instruments. In addition, a reference accelerometer is attached to the shaker and connected to a reference Dial-A-Gain. The specimen is then vibrated at a convenient 'g' level at a low frequency where the speciment acts as a rigid body. Then adjust the sensitivity dial of each channel so that the meter reads the same as the reference channel.

3) Standardization with an oscillator and voltmeter.

This approach does not require the use of a shaker. It also eliminates the need for calculating cable effects and allows checking for cable and accelerometer shorts or opens.

An accelerometer is a charge generator in parallel with its own capacitance. Any cable attached to the accelerometer appears in parallel with the charge generator also. Such a circuit is mathematically equivalent to a voltage generator in series with a capacitor. The sensitivity of the voltage generator is the sensitivity of the accelerometer with its cable as supplied by the manufacturer or by the calibration laboratory. The value of the series capacitor is the sum of the accelerometer capacitance and its cable capacitance.

To simulate the voltage generator described above, a very small resistor is inserted in series with the shield of the accelerometer cable at the end not attached to the accelerometer. An oscillator is used to impress a voltage across this resistor, thereby simulating a zero source impedance voltage generator in series with a capacitor consisting of the accelerometer and its cable. When the triax cable is connected to this circuit its effective capacitance is shunted across the above circuit.

Standardization is accomplished by adjusting the voltage across the series resistor to a value 10 times the accelerometer and cable sensitivity, thus simulating 10 g vibration. The gain of the channel is then adjusted to produce a meter reading of 10 g. This adjustment compensates for the loading of the triax cable. Frequency response of each channel can be checked with this same setup.

To check for shorted accelerometers or cables a large capacitor can be switched in parallel with the triax cable. This effectively adds additional cable loading and the output should decrease. If a short exists in "voltage generator" circuit then output will not decrease.

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CALIBRATION PROCEDURES
FOR
MODEL 610 DIAL-A-GAIN SERIES

Acceleration Channel

Note: Some models do not include input capacitor. To calibrate insert .5 mfd in series with oscillator but located at 610 input.

1. Check open loop gain.

   a. Set Sensitivity Potentiometer to maximum CCW.

   b. Connect oscillator to input and VTVM to ACC output (1V/g).

   c. Adjust output to 5V with range switch in 10-100 position.

   d. Measure input Volt. Should be less than .01.

2. Set Sensitivity Dial.

   a. Set frequency to 500 cps.

   b. Rotate dial maximum CW. Dial should read 10.13 $\pm$ 2 divisions. If dial is offset properly, skip step c.

   c. Carefully loosen screw and rotate dial CW 13 divisions with respect to shaft. Keep screw drag on shaft and dial free from panel. Lock screw at 10.13 point.

   d. Set dial at 10.0 and adjust output to 1.0 Volts on meter.

   e. Rotate Sensitivity Dial CCW until output reads 10. Read Sensitivity Dial.

      1. If sensitivity dial reads greater than one then offset dial CCW with respect to shaft the numbers of divisions that the dial reading is greater than 1.0.

      2. If sensitivity dial reads less than 1.0 offset CW.

      3. Repeat d and e until meter and dial agree.

3. Check Range Switch.

   a. Set range switch to 1-10.

   b. Set output to 10.

   c. Rotate range switch to 10-100.

   d. Output should be 1.0.

4. Check Maximum Drive

   a. Set sensitivity dial at 1.0.

   b. Set output to 100 g.

   c. Connect scope to output and check if distortion present at 10 cps, 50 cps, 500 cps, 5000 cps. At 10 cps set scope on D.C. Change V3 (7199) if waveform is distorted.
   Caution: At Higher frequencies, 3000 cps and above, the cable loading effect is quite pronounced. A short, low capacitance cable should be used.

5. Set Overall Gain at 500 cps.

   a. Set sensitivity dial at 10.0.

   b. Range Switch at 10-100.

   c. Set input to 1.0 on VTVM.

   d. Adjust acceleration potentiometer P1 until output reads 10.0.

6. Frequency Response

   a. Set output to 10.00 and frequency to 500 cps. Insert 1000 mmfd capacity in series with input at outboard end of 25 ft. triax. Output should not drop more than 4%. This is due to input capacity of cable.

   b. Repeat at 5 cps. Output should not drop more than 4%.

   c. Remove 1000 mmfd. cap.
   Set dial at 10, range switch 10-100, output at 10V and measure input required at 5 cps, 500, 5 KC, 10 KC. Should not vary more than $\pm$ 2%.

7. Meter Adjustment (For 610M, 610RM,610RM3 and 610RMG3)

   a. Set Oscillator to 500 cps.

   b. Adjust output (1V/g) to 10 volts on VTVM.

   c. Set meter full scale switch to 10. Meter should read 10. Adjust METER ADJUST P6 if necessary.

   d. Switch meter to 100 full scale. Wait a few seconds for meter to settle. It should now read ten at the bottom, i.e. 1.0 on meter scale. The adjustment screw on the front of the meter is provided to make this adjustment if necessary. If the low end requires adjustment, repeat c.

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MODEL 610

Checkout Procedure

Velocity Channel

The first half of V4 electrically integrates the signal passed through it (i.e introduces a 90° phase lag and a gain inversely proportional to frequency). This is accomplished by feedback from the plate to the grid through a capacitor whose impedance is large compared with the grid to ground impedance. The gain at any frequency is determined by the ratio of these impedances and therefore the gain can be set by adjusting the Trimit in the grid circuit. In order to adjust the gain of this stage, the frequency must be known accurately since the gain varies with frequency. If a counter is available, the gain may be set at any frequency. Otherwise, set the gain at 60 cps as follows:

1. Apply a 60 cps signal to the input of the 610 and adjust for 10g (i.e. 10 volts rms) at the acceleration output. This can be read at the AVD jack with the switch in the A position. To be sure that the input signal is 60 cps, apply the output to the vertical axis of an oscilloscope and introduce a signal from the power line on the horizontal axis. Adjust oscillator frequency to provide stationary ellipse on the scope.

2. Switch the AVD switch to Velocity and adjust the Velocity Trimit (in the first grid circuit of V4) to provide an output of 0.7 volts rms. This corresponds to a velocity of 10.24 in./sec. vector.

3. Recheck frequency, acceleration and velocity.

4. Check velocity frequency response

   Set frequency 3000 cps with counter
   Set acceleration output at 10 volts
   Read velocity output on voltmeter.
   (Should be 70 millivolts. If it is too high, adjust by decreasing the 470 ohm resistor in series with the .068 mfd capacitor at the plate. Some models include a 470 ohm pot; others can be adjusted by shunting the 470 ohm resistor. Set 2% high at 3000 cps.

5. Check Vel. Cal. output on 610R-12

   Set frequency 500 cps
   Dial at 681
   Range Switch 10-100
   Input at 1 volt
   Vel. Cal. output should be 1 volt

Model 610 Checkout Procedure (cont.)

Displacement Channel

To adjust the displacement stage which is an integrator similar to the velocity stage:

1. With frequency set at 60 cps and acceleration at 10 g as set above, adjust the displacement Trimit so that the displacement output reads 54.4 millivolts.

2. Repeat at 80g where the acceleration output should be 80 volts rms and the displacement output should be .435 volts.

Galvanometer Amplifier Check (Model 610RMG3)

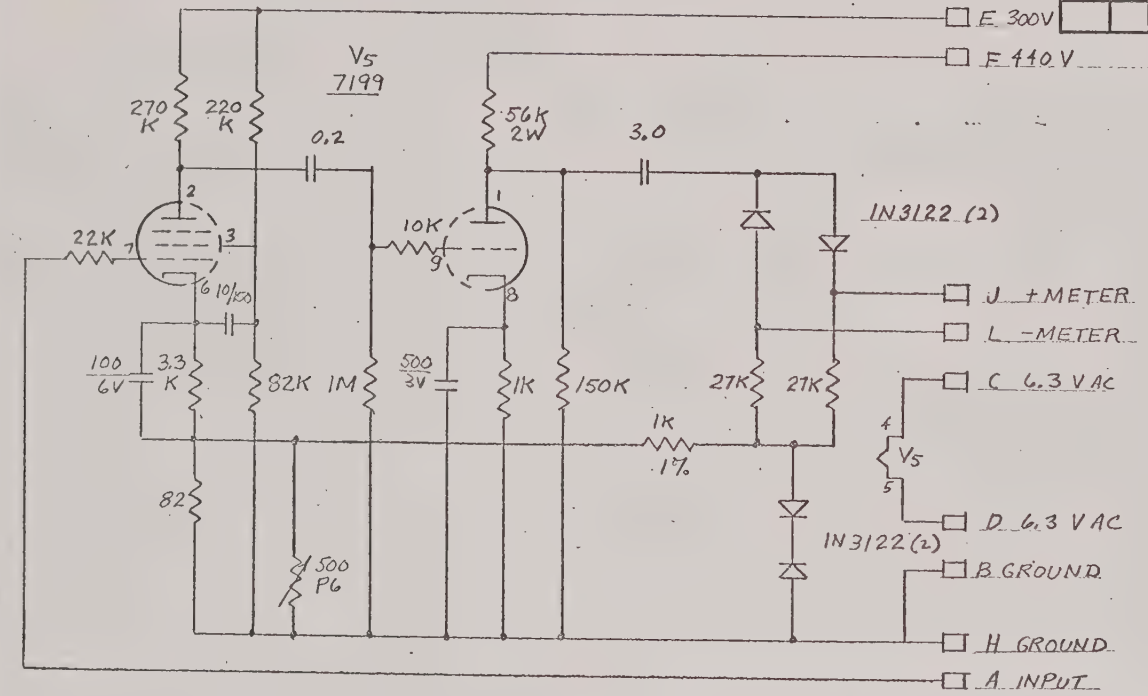
a. Set oscillator to 500 cps.

b. Connect galvanometer output to VTVM and scope with 70 ohm resistor shunting the VTVM input terminals. Turn galvo gain adjust (front panel) CCW.

c. With 610 meter set a 10 full scale, adjust oscillator for full scale deflection.

d. Rotate galvo gain clockwise watching galvo output waveform on scope. No distortion should be present up to 5 V (RMS).

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

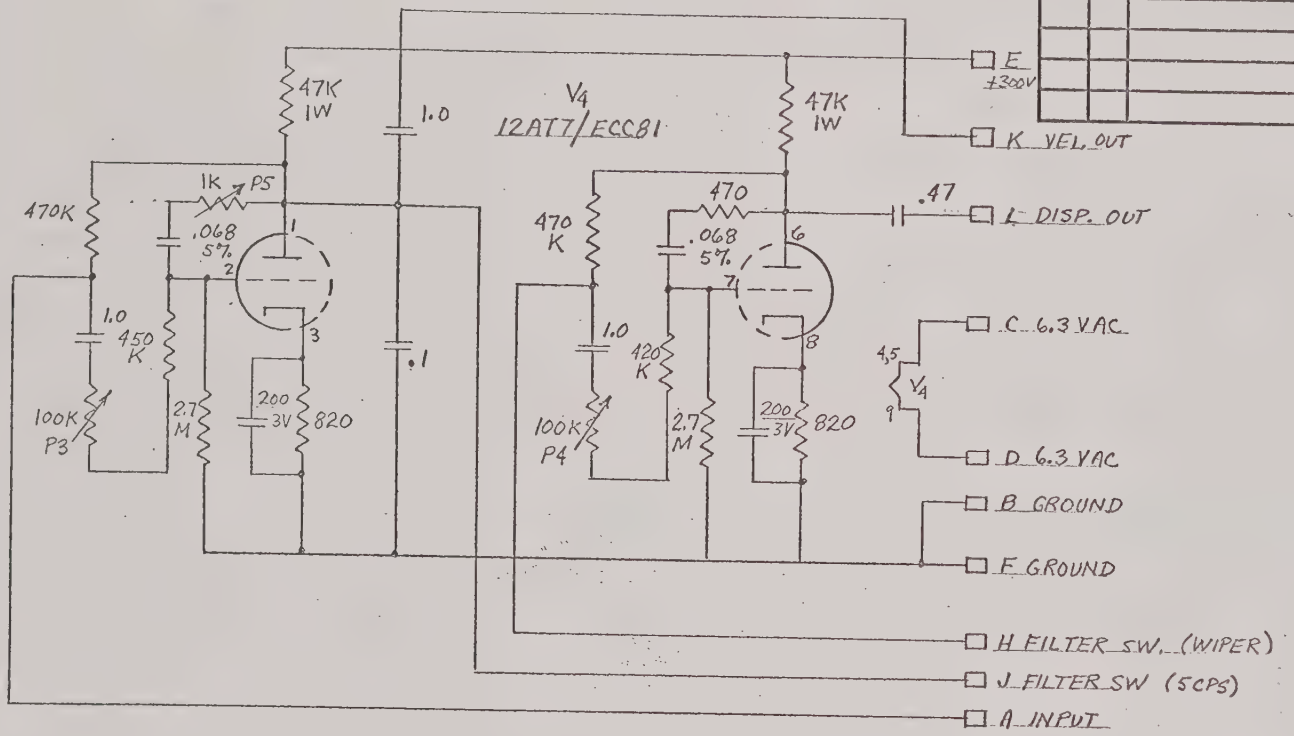


TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ - DICKIE CORP.		
DECIMAL ±		SCALE	DRAWN BY B.W.
			APPROVED BY
FRACTIONAL ±	TITLE METER MODULE - 610 SERIES		
ANGULAR ±	DATE 1-3-63	DRAWING NUMBER 9104283	

K&E 199LFE-1 ALBANENE ENGINEERS' STANDARD FORM

MADE IN U.S.A. 25012

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.

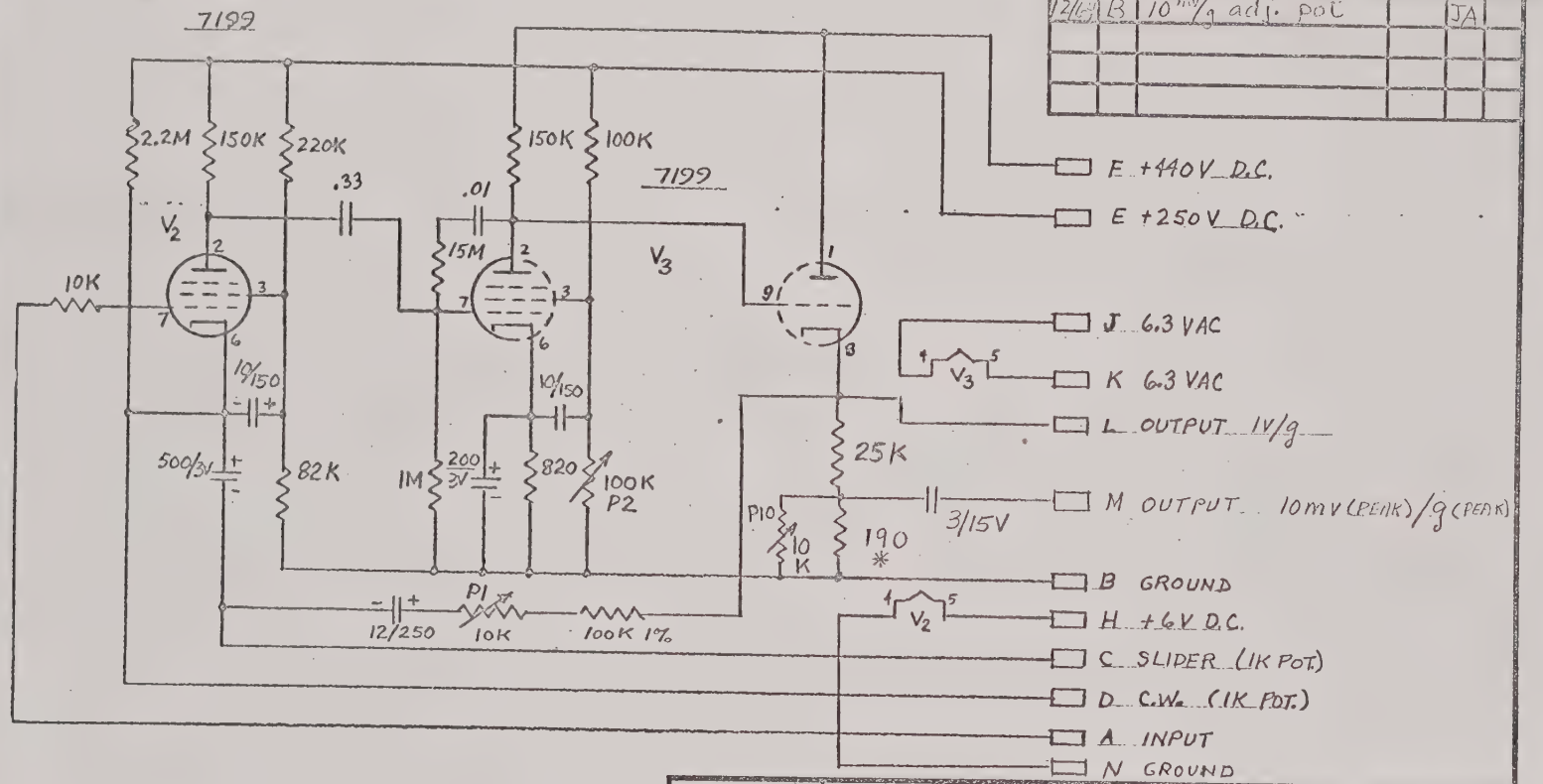


TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ - DICKIE CORP		
DECIMAL ±		SCALE	DRAWN BY B. W.
			APPROVED BY
FRACTIONAL ±	TITLE: DOUBLE INTEGRATOR MODULE		
ANGULAR ±	DATE: 1-3-63	DRAWING NUMBER: 9104284	

K&E 185LPE-1 ALBANENE ENGINEERS' STANDARD FORM

MADE IN U.S.A. 25612

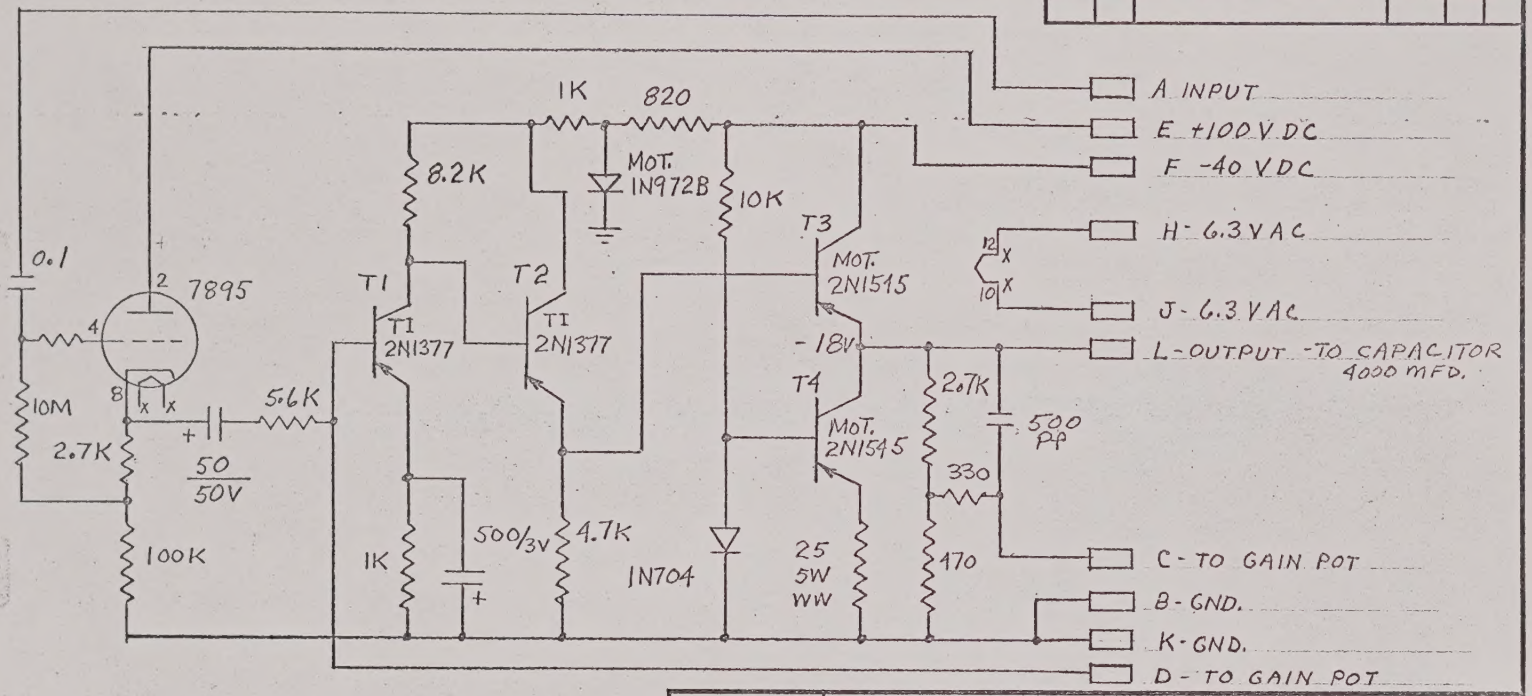
DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
1/1	A	CATHODE R V3 2.5K			
12/63	B	10 mv/g adj. POT		JA	



* RESISTOR SHUNTED TO PROVIDE OUTPUT OF 10MV (PEAK) /g ('PEAK)

TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ - DICKIE CORP.		
DECIMAL ±		SCALE	DRAWN BY B. W.
			APPROVED BY
FRACTIONAL ±	TITLE DIAL-A-GAIN MODULE 610 SERIES		
ANGULAR ±	DATE 1-3-63	DRAWING NUMBER 9104289	

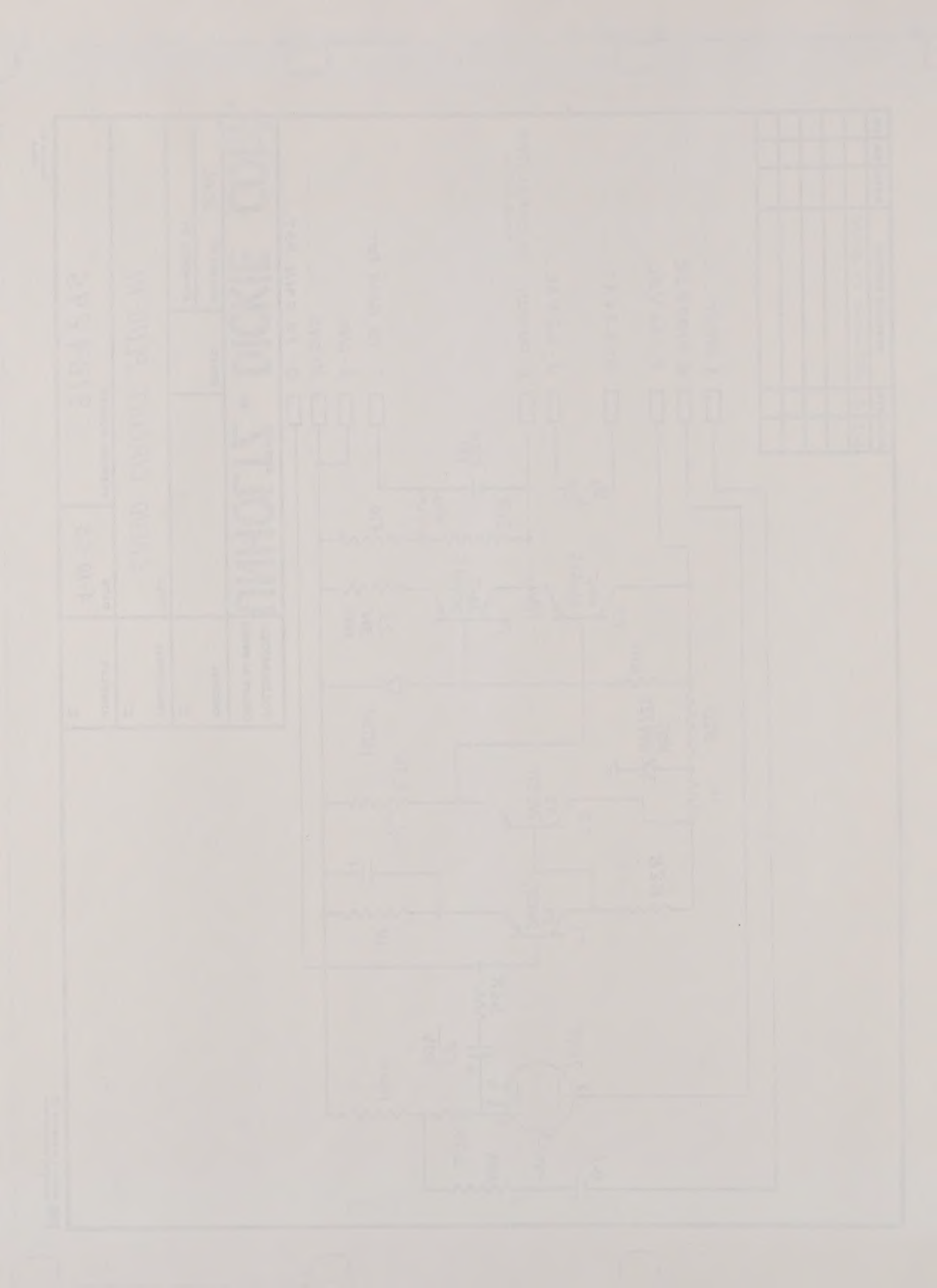
DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
6-1	A	.001 OUTPUT TO 500PA			



TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ - DICKIE CORP.		
DECIMAL ±		SCALE	DRAWN BY B.W.
			APPROVED BY
FRACTIONAL ±	TITLE GALVO CIRCUIT PLUG-IN		
ANGULAR ±	DATE 4-10-63	DRAWING NUMBER 9104296	

K&E 195LFE-1 ALBANENE ENGINEERS' STANDARD FORM

MADE IN U.S.A. 25512



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